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Simplifying CAD/CAM Dentistry

Chairside CAD/CAM designing and milling are not as complex as they may seem

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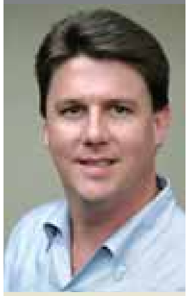

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The fast track to CEREC® excellence

Becoming proficient with one mode at a time helps take the mystery out of CAD/CAM dentistry

ABSTRACT

The use of CAD/CAM technology in dentistry is increasing, both in the dental laboratory and general practice settings, to fabricate all-ceramic inlays, onlays, crowns, and veneers. Only one CAD/CAM system is currently available for in-office chairside use, CEREC® 3D by Sirona Dental Systems. There exists a misconception that the CAD/CAM process is complicated and time-consuming. However, this CAD/CAM system is simple to operate, versatile, and precise. All-ceramic restorations can be designed and milled chairside, traditional impressions and temporaries are eliminated, and the patient leaves the appointment in about an hour with a final restoration in place. Dental CAD/CAM is approaching 20 years of clinical experience and has a proven track record on all relevant aspects of clinical performance, including fit, longevity and survival rates, sensitivity, strength, and wear. This article illustrates the simplicity of the basic skills necessary to achieving restorative goals with chairside CAD/CAM technology.

By Dr. Alex Touchstone

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One of the earliest memories I have of family vacations are those of a camping trip we made around my fifth birthday. We loaded up the station wagon, complete with the obligatory pop-up camper in tow, and set off to a KOA campground to "rough it" for an entire week. The image of my Dad fighting with that camper in the Mississippi heat is one of my favorite childhood recollections to this day. At daybreak on the second morning, Dad took me to the pond for my first-ever fishing experience. We caught so many catfish that day that I naturally fantasized that the key to fishing was simply to pick a spot, put the hook in the water, and pull 'em in as fast as you could.

Fishing, it turns out, has as many varied techniques as fish, each with its own unique tackle and recipe for success. Folks who fish will tell you that each type is both fun and rewarding. Moreover, the number of fish one catches is directly proportional to the time spent with the hook in the water.

So it is with chairside computer-aided design/computer-aided manufacture (CAD/CAM) dentistry. The science of CAD/CAM dentistry has expanded rapidly in the last few years. The types of restorations possible using such systems are almost as varied as the dentists who embrace the technology. The level of esthetic and functional potential of CEREC® (Sirona Dental Systems LLC) restorations is limited only by one's imagination and drive to learn.[1,2] Because it is currently the only chairside CAD/CAM system available, this article focuses exclusively on the CEREC system. This chairside CAD/CAM system is approaching 20 years of clinical experience and has a proven track record on all relevant aspects of clinical performance, including fit,[3-5] longevity[6-10] and survival rates, sensitivity,[11] strength,[12-14] and wear.[15]

While each CEREC application in and of itself is simple and straightforward to learn, much like my early fishing experiences, sometimes CAD/CAM looks more complex because of the many different options it offers. In order to reap the rewards promised though, one must keep the "hook in the water" with regard to gaining experience and understanding of the workflow associated with creating each type of restoration possible. It is a good idea to focus one's learning on a single type of restoration and become proficient in that first, before adding new applications to one's portfolio.

The purpose of this article is to give the reader a clear understanding of the thought processes that surround making a decision about which method to employ when fabricating CAD/CAM restorations with the CEREC system, and to illustrate the simplicity of the basic elements of those decisions.

Two cases illustrate achieving restorative goals with chairside CAD/CAM technology. The first

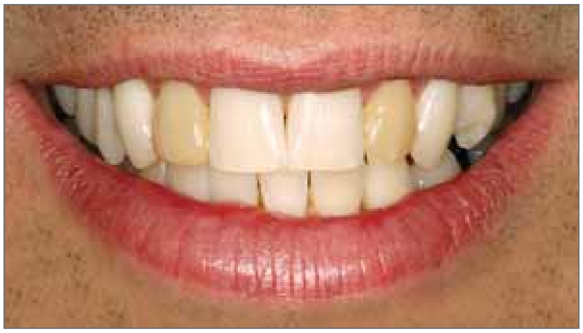

FIG. 1: Preoperative smile.

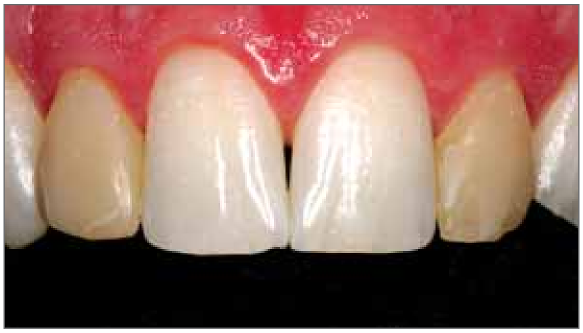

FIG. 2: Close-up of chipped veneers.

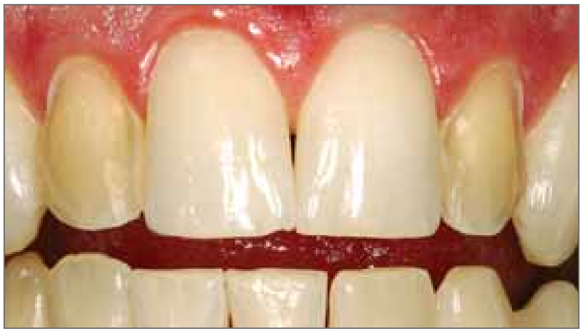

FIG. 3: Tooth preparations.

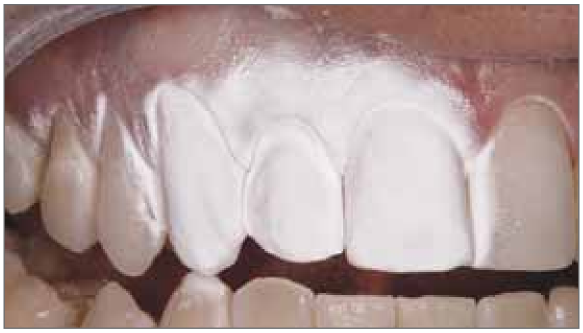

FIG. 4: Contrast medium applied to preparation.

addresses the precise control of the fit and esthetic outcome possible when fabricating veneers with CEREC.[16,17] The second demonstrates that even dental students with limited experience can grasp the simple concepts necessary to design and mill posterior restorations with CAD/CAM technology.

CASE ONE:
Lateral incisor veneers

A 34-year-old patient presented with poorly matched composite veneers on teeth Nos. 7 and 10. The discrepancy was made more dramatic by recent at-home bleaching procedures (Figure 1). Additionally, both veneers were chipped—tooth No. 10 to a greater degree than tooth No. 7—which ultimately resulted in the use of two different design techniques in the process of fabricating each veneer (Figure 2).

After discussing several restorative options, the patient chose to have the veneers replaced with CEREC 3D custom-milled restorations. The CEREC R2005 software includes three design techniques: Dental Database (with and without Antagonist), Correlation, and Replication.[18] Deciding which one to use is influenced by the condition of the tooth before the preparation is started. If the tooth has a generally desirable form that the clinician wishes to copy, then the Correlation mode is the technique of choice. If, however, one feels that the condition of the tooth is such that copying it would result in undesirable tooth form or occlusal relationship, then either the Replication or Dental Database techniques apply. Replication allows the user to copy and mirror the contra-lateral tooth, thus maintaining perfect symmetry in the critical anterior smile zone. The Dental Database method allows one to create a new restoration by choosing from one of seven different databases of teeth stored in the software and offers the greatest freedom for altering tooth morphology (Table 1).

LEARNING OBJECTIVES

After reading this article, the reader should be able to:

DISCUSS some of the advantages to using chairside CAD/CAM technology.

DESCRIBE the software design modes and the thought processes involved in deciding which to use for each restorative situation.

EXPLAIN the basic steps of designing veneers with the Correlation and Dental Database modes.

DISCUSS the subsequent restorative material decisions necessary to control the esthetic outcome.

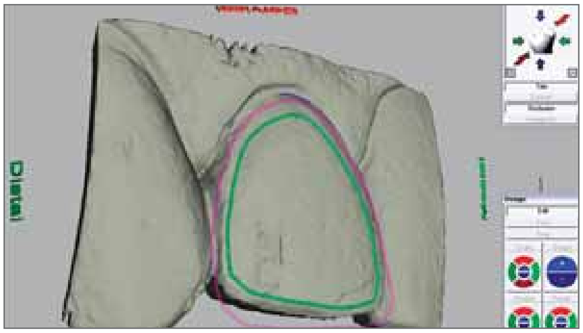

FIG. 5: Defining copying area.

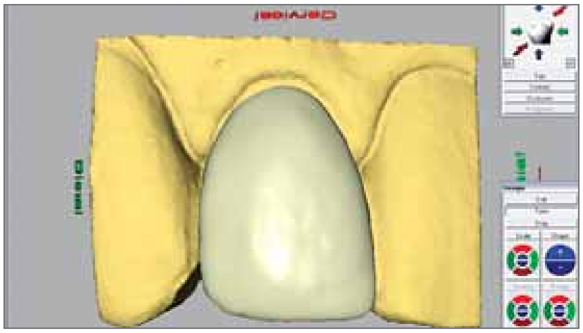

FIG. 6: Finished veneer design for tooth No. 7.

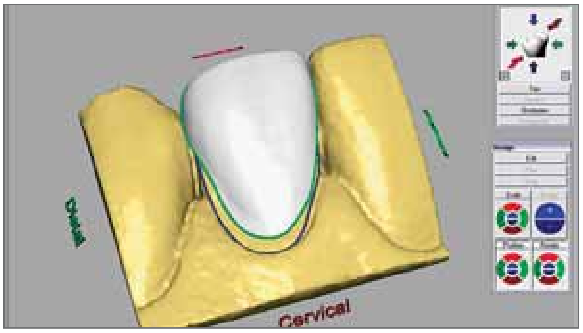

FIG. 7: Shell in position over prep.

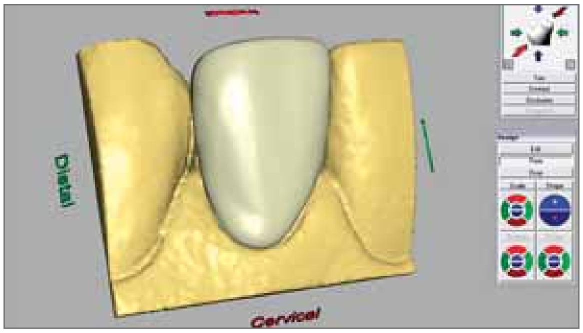

FIG. 8: Finished veneer design for tooth No. 10.

TABLE 1

CEREC design modes

DESIGN TECHNIQUE	RESTORATIVE METHOD	APPLICATION
Correlation	Copy the tooth to be restored	Most often used, very simple
Replication	Copy any tooth surface	Ensures bilateral symmetry
Dental Database (with Antagonist)	Start from scratch	Maximum freedom to alter morphology (taking antagonist into account when designing occlusion)

There is a common misconception that anterior restorations, particularly veneers, are difficult, time-consuming, and unpredictable with CEREC. The reverse is actually true. The level of control over the form of the veneer afforded the dentist as well as the esthetic outcome actually make CEREC veneers one of the more simple processes of CAD/CAM dentistry.[18] Once the decision to create a veneer for tooth No. 7 by Correlation and a veneer for tooth No. 10 by Dental Database was made, the process of preparing the teeth, fabricating and finishing the veneers, and finally seating them was accomplished in about 2 hours.

The criteria for selecting the Dental Database technique for tooth No. 10 were:

- Defects present in the form of the tooth (chipping on the incisal third).
- Absolute symmetry not required for these restorations (notice the subtle asymmetry of teeth Nos. 8 and 9).

First, it was determined that the preoperative morphology of tooth No. 7 corresponded to the desired outcome. Therefore, an optical impression of tooth No. 7 was made before it was prepped, to be copied later in the design of the veneer. The chip in tooth No. 10 led the author to use Dental Database to design the restoration, rather than creating a copy; thus, a pre-operative image of No. 10 was not required. Next, both teeth were prepared with a labial reduction of approximately 1 mm (Figure 3).

The preparation for tooth No. 7 was lightly powdered with a contrast medium, and an optical impression was captured (Figure 4). The contrast medium allows for the accurate registration of the exact dimensions of the preparation and surrounding structures by the camera and thus is an essential element of the technique.[19-21] The veneer then was designed using the Correlation design technique, with the pre-treatment form of the tooth copied precisely (Figures 5 and 6).

There actually are only four main steps to designing a veneer in Correlation mode, requiring a total of about 3 to 5 minutes (Table 2). As with developing

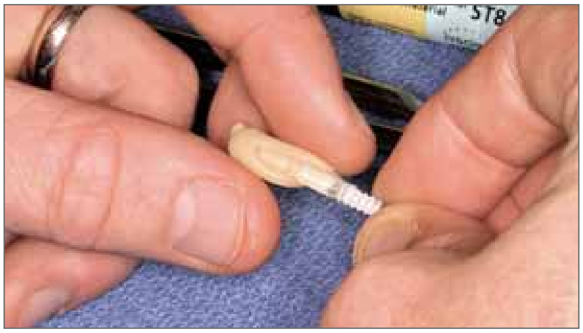

FIG. 9: Creation of stump die.

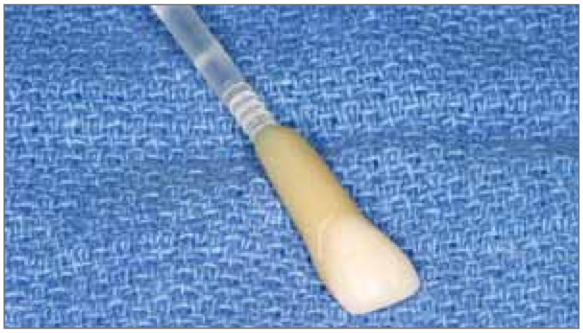

FIG. 10: Veneer in place on die.

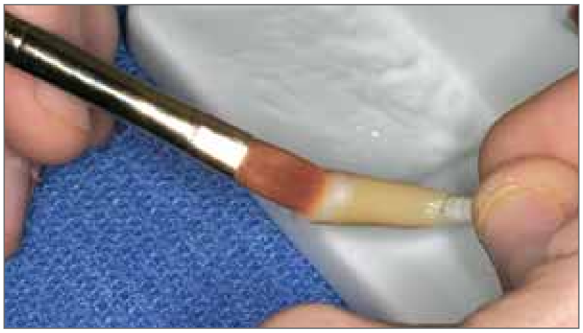

FIG. 11: Proper application of glaze.

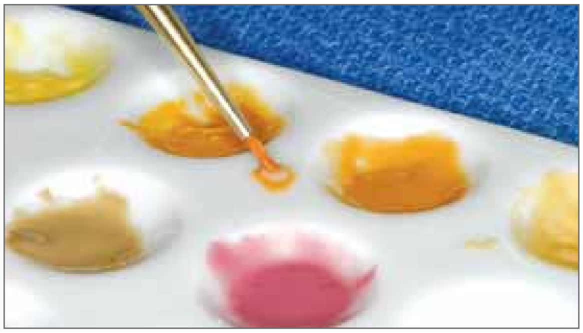

FIG. 12: Mixing glaze with stain before application.

new skills in any area, what may have taken longer to do the first time (like your first prep in dental school) becomes less laborious and easier as proficiency builds. Being familiar or proficient with the CEREC software in one mode will enable the user to transfer technique and confidence when adding another restoration type to his or her CEREC armamentarium.

As previously mentioned, the Dental Database design technique was chosen for the creation of the veneer for tooth No. 10. Using the Dental Database mode, the user is afforded the opportunity to choose and precisely orient a shell that represents the form of the restoration over the preparation image of the tooth that is to be restored (Figure 7).

The design process for the veneer of tooth No. 10 was completed in 3 to 5 minutes, and resulted in the desirable tooth form (Figure 8). Table 3 outlines the steps to successful veneer fabrication using the Dental Database technique.

TABLE 2

Correlation mode design steps

DESCRIPTION	ACTIVITY	AVG. TIME REQUIRED
Margin Finder	Draw the prep margin	30 seconds
Labial Contour	Establish the proper emergence profile	1 minute
Copying Line	Define the area copied	30 seconds
Finish	Refine the contours	1 minute

Controlling esthetics

At this point, the CEREC-specific aspects of the process are essentially finished. All decision-making from here on out is based on an understanding of how to control the esthetics of any non-opacious, all-ceramic restoration, and thus, is similar to those decisions faced in any traditional ceramic veneer process. The desired outcome is easy and predictable to achieve, if a few simple but essential factors are taken into consideration:

1. The influence of the color of the prepped tooth on the resultant shade.
2. Various options available to create shade and translucency gradients.
3. The range of effect that the bonding layer has on the brightness of the veneer.

Let's look at how these were assessed in this particular case. Before milling the restoration, the appropriate shade of ceramic block (Vita 3D OM1, Vident) was selected, taking into account the influence of the prepped tooth on the final shade of the restoration. The author has found that generally speaking, at a restoration thickness of 1 mm and

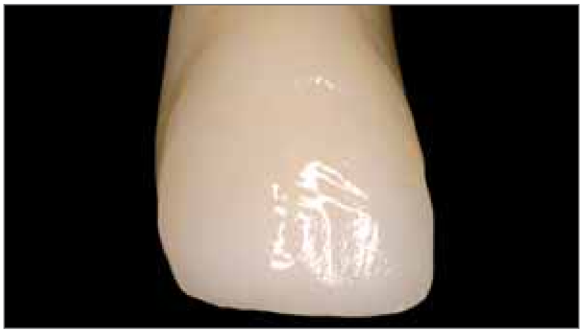

FIG. 13: Veneer for tooth No. 7 on die.

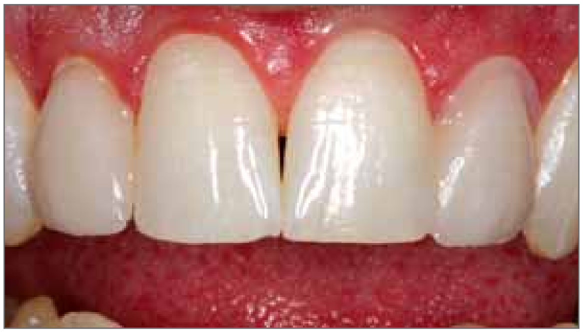

FIG. 14: Selection of cement shade using try-in paste.

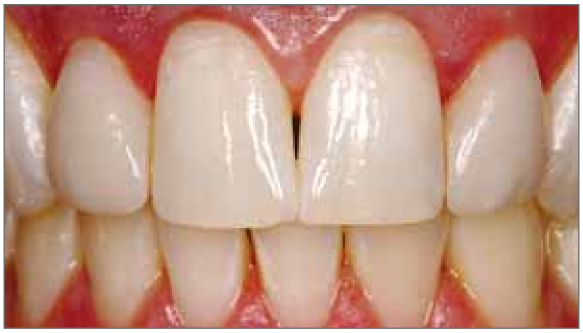

FIG. 15: Postoperative retracted view.

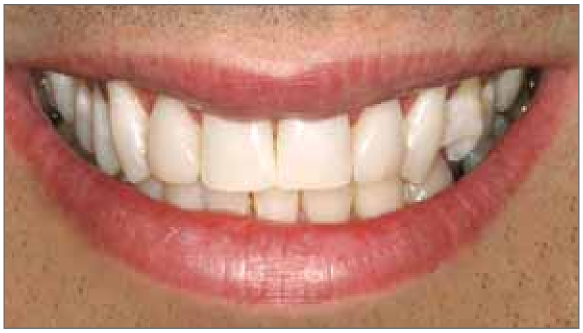

FIG. 16: Postoperative smile view.

TABLE 3

Dental Database design steps

DESCRIPTION	ACTIVITY	AVG. TIME REQUIRED
Margin Finder	Draw the prep margin	30 seconds
Position the shell	Adjustments to match adjacent tooth contours	1–2 minutes
Finish	Refine the contours	1 minute

using the Vita 3D Master (Vident) shade system, if the prepped tooth is one value group darker than the desired shade, then a ceramic selection that is one value group brighter will result in the correct final shade. Throughout the process, the EasyShade (Vident) was used to confirm the desired preparation and final restoration shades. The desired final shade was Vita 3D 1M1.

After both veneers were milled, a further evaluation of the final shade of the restorations was accomplished using Empress (Ivoclar Vivadent) die material (Figure 9), a type of composite resin that can be formed into a stump die that approximates the shade of the prepped tooth.

While polishing alone often is sufficient to create desired luster, a stain and glaze procedure was performed in this case in order to create subtle characterizations. If properly controlled, the stain and glaze procedure is fast, simple, and predictable. Most practitioners are experienced with the general concepts of this process. The glaze is first adjusted in viscosity so that it has the consistency of honey. It then is carefully applied to the surface of the restoration in a thin layer, taking care not to allow material to flow over to the bonding surface of the restoration (Figure 11).

Next, adding the appropriate stains creates the desired effects in just one application (Table 4). This technique allows one to fire the restoration once rather than multiple times, and thus speeds the process significantly. The total time for staining and glazing following this technique is approximately 20 minutes, and this is easily integrated into the one-visit procedure. It is important to note when using a single-firing technique that in order to avoid inadvertently removing the glaze when applying stain, one should mix a little glaze with stain material before application (Figure 12).

Both veneers were fired in a single cycle per the stain manufacturer's recommendations. The appearance of the veneer for tooth No. 7 on the die after firing is illustrated in Figure 13.

The final step in controlling the shade of anterior CAD/CAM restorations lies in the proper selection of a bonding agent. The value component of the shade is most critical here; therefore, a resin should be chosen that falls in the appropriate value arrangement. In this author's experience, light-cured resins are desirable over dual-cured resins because of their improved color stability over time. In this case, Appeal Anterior Resin (Ivoclar Vivadent) was selected because it possesses the aforementioned desired attributes. The veneers were tried-in with try-in paste to facilitate proper selection of the cement (Figure 14). Appeal LV-1 resulted in the desired final shade. The restorations were bonded following the recommended protocol.

TABLE 4

Stain effects and mixing ratios

STAIN COLOR	DESIRED EFFECT	MIXING RATIO, GLAZE:STAIN
Blue, violet	Incisal translucency	10:1
Oranges, tans, ochre	Increased depth or chroma	1:1
White	Focal effects	Varies

Discussion

Case one demonstrates the ease with which general practitioners can use the CEREC system and its companion restorative materials to design, mill, custom-color, and seat anterior restorations in a single visit. The process from start to finish took just over 2 hours to complete. The patient received highly esthetic, conservative anterior veneer restorations (Figures 15 and 16) in a process that was completely controlled by the practitioner with a chairside CAD/CAM technique. Looking at the entire process, the active time spent on the CAD/CAM equipment was less than 10 minutes of the overall treatment time; milling took approximately 8 minutes per veneer; and staining, glazing, and firing took about 15-20 minutes. The patient was very pleased with the results and his smile is now well-matched.

CASE TWO:
CEREC in dental schools

By Dr. Randy J. Phillips

There is a substantial body of scientifically sound evidence to support the efficacy of indirect, bonded ceramic restorations as a valid treatment modality. Recognizing the need to prepare our graduating dental students to respond to the esthetic demands of patients that these restorations provide while continuing to achieve predictably excellent outcomes, the University of Southern California School of Dentistry has made a significant addition to its predoctoral curriculum to include not only exposure to these techniques, but competence with them, as well.

Included in these additions is the concept of CAD/CAM technology, which has been available to the dental profession for approximately 20 years, and recently has become a somewhat routine method of fabricating indirect, bonded ceramic restorations in private practice. However, surprisingly few dental curricula contain both theoretical and practical instruction in this technology. The goal of our pilot program, which began in April 2005, was to develop a curricular element for undergraduate dental students that would provide both. CEREC® 3D (Sirona Dental Systems LLC) currently is the only chairside CAD/CAM restoration fabrication product commercially available to the dental profession, and it has been used in our program exclusively.

With no previous student-setting history to draw from, the scope of the initial course was limited to preparing for, designing, milling, staining and glazing, and bonding posterior inlay, onlay, and overlay (crown) restorations on Typodonts and mounted extracted teeth using the Antagonist mode. The Antagonist mode was chosen for our initial venture into the course because it most closely resembles the more traditional methods of indirect restorative techniques that the students had been exposed to previously. An impression of the preparation, as well as a bite registration to capture the occlusal relationship with the opposing dentition, is used to create the restoration. However, unlike the traditional laboratory processed restoration, infrared optical impressions[19] are used to create a "virtual" model and die on which a "virtual" restoration is designed by the user on a computer screen. This design in turn is fabricated by the milling unit.

After an orientation exposing students for the first time to the concepts unique to CEREC compared to more traditional methods, it became quite evident that the ability of novice CEREC users to use the technology had been vastly underestimated. The subtle differences in preparation design required for CEREC-fabricated restorations, as well as the concepts of powdering and optical impressions versus making polyvinylsiloxane (PVS) impressions, were readily assimilated by the students, as was the design

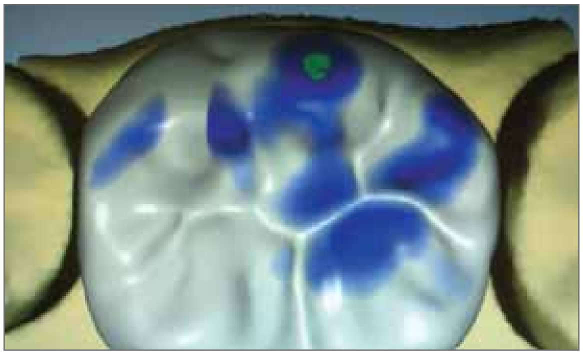

FIG. 17: Student-designed proposed restoration done in Antagonist mode.

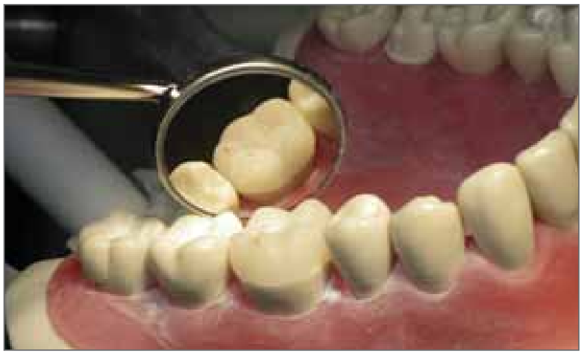

FIG. 18: Initial student exercises done on equilibrated Typodonts.

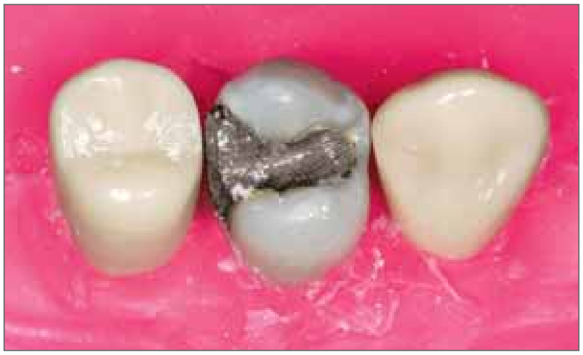

FIG. 19: Students expand their CEREC experience to the Correlation mode of design.

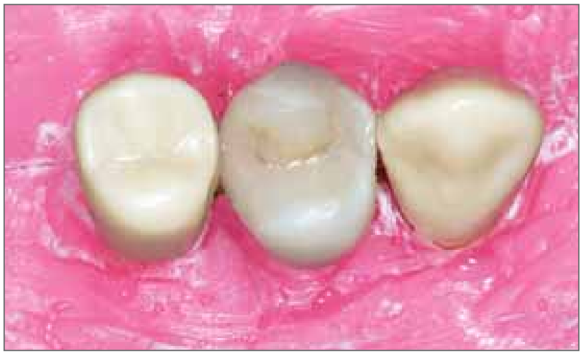

FIG. 20: Inlay designed in Correlation mode and seated on tooth No. 5.

process itself. Their first exercises were done on an equilibrated Typodont and the results were excellent (Figures 17 and 18).

After another session, in which mounted extracted teeth were similarly restored with CEREC-fabricated restorations that had been stained, glazed, and bonded in place according to established protocol, it was determined that sufficient progress had been made by the students to expand their CEREC experience to the Correlation mode of design and fabrication. The CEREC Correlation mode allows a desirable occlusal morphology to be copied and eliminates the need for a bite registration to be taken, powdered, and optically impressed. In those cases where the preoperative clinical condition is favorable (e.g., an existing intracoronal restoration with gingival defect), the Correlation mode can produce a precise copy of the preoperative occlusion and morphology.

The students were given a brief resource session on the dynamics and application of the Correlation mode and were then instructed to complete and bond a restoration on an extracted tooth within the time constraints of a typical clinical session (3 hours). The time-frame goals for these sessions were as follows: preparation and optical impression, 1 hour; design and mill a CEREC-fabricated restoration, 45 minutes; adjust and polish the restoration, 15 minutes; stain and glaze the restoration, 30 minutes; bond and debride the restoration, 30 minutes. It is important to recognize that these time limits have been somewhat arbitrarily applied to the parameters of a typical clinic session at USCSD and do not reflect the time actually required to perform the procedures. Typically, the time a dental student will spend on a given clinical task is equal to the time allotted for that task. Again, the results surpassed expectations and exceeded the criteria for clinical acceptability (Figures 19 and 20).

The next challenge for the students was to successfully complete a Qualifying Competency Exam consisting of a timed exercise in which an extracted tooth is prepared and restored with a CEREC-fabricated restoration. Without exception, the students were able to accomplish the task well within the timeframe of a typical clinic session and were certified as competent to provide this treatment for patients in the predoctoral clinic (Figures 21-24). Powdering, optical impressions, and bonding were accomplished with rubber dam isolation.

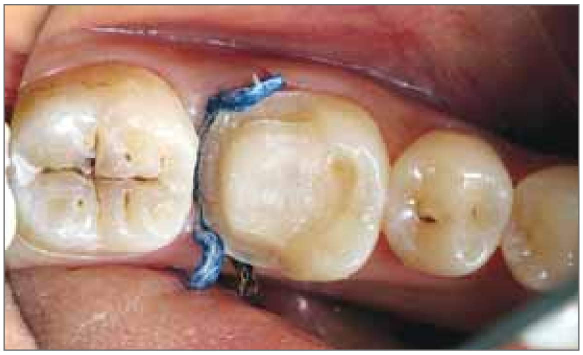

FIG. 21: Posterior inlay prep, done in dental school clinic.

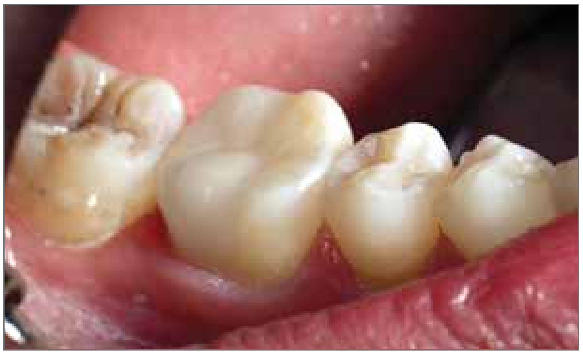

FIG. 22: Completed inlay seated, buccal view.

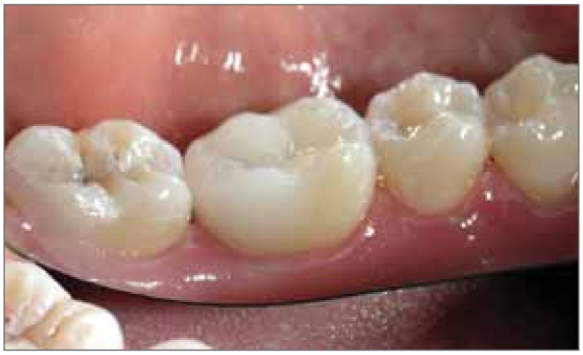

FIG. 23: Lingual view of final inlay restoration.

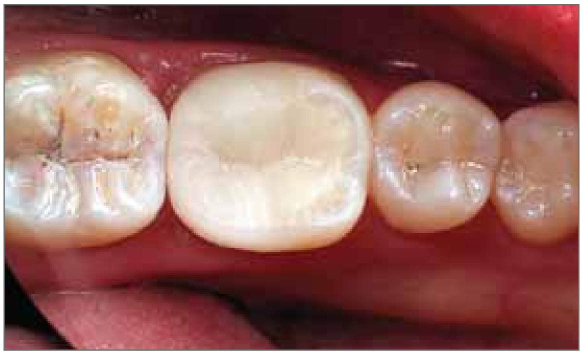

FIG. 24: Occlusal view of the final.

These results of the first series of sessions have been repeated with subsequent groups of students. It has been very apparent that the learning curve relative to CEREC-fabricated restorations is very steep, but also very short and poses no real obstacles to the novice user of the design software. Admittedly, the number of students who have thus far been trained in the use of CEREC 3D is small, but the preliminary results are very encouraging. It seems obvious that the only limitation to training the entirety of the pre-doctoral senior class is in direct proportion to the limited number of CEREC acquisition and milling units currently available at the school.

Additionally, it seems apparent that the students are capable of understanding and mastering the concepts of the Antagonist and Correlation modes of restoration design with relative ease. The majority of the time required for completing the CEREC-fabricated restorations was spent on tooth preparation and bonding rather than restoration design. This is not surprising, as even senior students labor over the exacting use of highspeed handpieces and relatively unfamiliar dental materials. It is evident that dental students are capable of applying their fundamental restorative principles to the use of CAD/CAM technology through a focused experience, and that proficiency can be achieved rather rapidly, regardless of the design mode applied. It also appears that by utilizing CAD/CAM technology with its multiple applications, the potential exists to treat a large percentage of our clinic patients requiring posterior restorations, with minimal additional training. By restricting the initial learning goals to the two modes of restoration described, we have attempted to expose the students to methods of restoration fabrication that they would most often use, while at the same time preventing them from being overwhelmed by the large number of alternative applications for CAD/CAM dentistry available to the more experienced practitioner.

Conclusion

Both cases presented illustrate the fact that chairside CAD/CAM dentistry affords both experienced dentists and dental students the opportunity to enjoy enhanced control over the restorative process. In both instances, the operators started out with the simplest approaches to fabricating chairside-milled restorations before progressing to somewhat more advanced or esthetically challenging types of

TABLE 5

Resources

For information on CEREC milling materials and product selections, please contact the following manufacturers:

Ivoclar Vivadent Inc.
800-533-6825
(800-263-8182 in Canada)
www.ivoclarvivadent.us.com

Sirona Dental Systems LLC
800-659-5977
www.sirona.com

3M ESPE Dental Products
800-634-2249
www.3MESPE.com

Vident
800-828-3839
www.vident.com

processes. Additionally, it has been demonstrated in both settings (general practice and dental school) that the majority of time is spent on tooth preparation and final restoration seating, rather than designing the restorations. Using the CEREC system has proven to be easily incorporated into everyday practice, despite its perceived learning curve. Dentists and dental students have reported that learning to operate the software and fabricating reproducible and predictable results has increased their enjoyment and level of personal fulfillment. With minimal experience, they are able to provide high-quality all-ceramic final restorations in one appointment (often only an hour in duration).

As with fishing, where the number of fish one catches is directly proportional to the time spent with the hook in the water, the quality of the CEREC restorations one can provide for patients desiring all-ceramic, single-visit crowns, veneers, inlays and onlays, depends upon the time investment clinicians are willing to make in enhancing their own skills. Tackling the moderate learning curve, mastering the software, and applying the basic principles that are already part of the general practitioner's daily routine are well worth the effort.

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Disclosure

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Photo courtesy of Sirona Dental Systems

Crowning moments

PFMs still rule the roost, but CAD/CAM-based systems are expanding your choices for indirect restorations and this survey report shows that their use is on the rise.

By Stan Goff

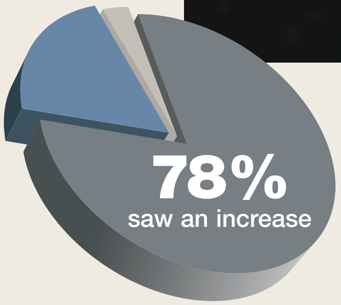
Lee Culp, CDT, sees the day where CAD/CAM restorations will be the norm.

We are seeing a substantial increase in laboratory-fabricated CAD/CAM all-ceramic crowns, such as Cercon (Dentsply Ceramco), Lava (3M ESPE), CEREC inLab (Sirona Dental Systems LLC) and Procera (Nobel Biocare). Our latest survey[1] shows that 27% of our readers regularly place these crowns, a healthy jump from the 18% who indicated they were doing so in last year's DPR survey.[2] This latest survey also shows that 12% of you are regularly placing CAD/CAM all-ceramic bridges.

"It's growing and it will continue," Culp said of CAD/CAM restorations. "If you wanted to do all-ceramics in the past, you were stuck with bonding. Zirconia restorations can be cemented in conventionally with glass ionomer or resin ionomers. There's no clean-up, no special techniques and dentists are loving it."

But the bottom line is doctors and patients still want restorations that look good and last long. Close to 80% of the survey respondents (see "Looking good" chart, at left) said the patient demand for restorations **for strictly cosmetic purposes** has increased in the past five years. Advances in CAD/CAM systems are delivering such results, but traditional porcelain-fused–to-metal restorations are still the most popular choice by far (see "PFMs still the way to go" chart, page 14). PFM crowns (95%) lead the way with our readers as the most commonly placed type of restorations, while PFM bridges were next at 92%. All-

DENTAL PRODUCTS REPORT SURVEY



Looking good

Almost four in five respondents said that patient demand for restorations **for strictly cosmetic purposes** has increased in the past five years.

Increased	78%
Stayed the same	19%
Don't know	3%

Source: August 2005 DPR Indirect Esthetic Restorations Survey gold crowns and porcelain veneers were next on the list, each being done by seven in 10 respondents.

PFMs' dominance

While plenty of metal-free options exist, there are good reasons why PFMs and even all-gold restorations remain popular. PFM crowns and bridges boast strength, longevity, and function, and for years have offered up adequate esthetics to please both doctors and patients in most cases. But with just 18% regularly placing all-metal crowns, it is clear once again that esthetics play a big role in which restorations are chosen.

Nick Azzara, president of Captek (Precious Chemicals Inc., *www.captek.com*), said his company's proprietary crowns and bridges offer the esthetics dentists and patients clearly want along with the durability and ease of use of traditional metal ceramics. While there was not a specific mention of Captek on the survey, he believes many doctors consider Captek crowns and bridges as PFMs, even though, according to Azzara, there are distinct differences.

"The demand for esthetic restorations is the trend. Yet it's also clear that doctors are still utilizing metal ceramics due to the ease of use, the versatility, familiarity, cementability, and certainly strength." Azzara said.

"Dentists are getting more comfortable with the concept every year," he said. "And while they're looking to Captek as an esthetic solution, they're also getting other significant benefits; one being that Captek is clinically proven to repel plaque and bacteria. This is no small feature and in many cases has become the most appreciated benefit of this material."

Photo courtesy of Captek

Captek is a substructure for ceramics and is referred to as a metal-composite or internally reinforced gold. The high gold within the copings are supported internally by a structure of high-fusing particles of platinum and palladium. The metal exhibits an oxide-free, warm color that supports vital-looking porcelain and eliminates dark lines at the margins.

Culp said a survey conducted by Ivoclar Vivadent a couple years back suggested an interesting trend: that all-ceramic and metal-ceramic restorations were both on the rise. That's why he's not the least bit surprised to see PFMs still leading the way in our latest survey.

"You would expect that as all-ceramic restorations grow, metal ceramic restorations would decline," said Culp. "They found, however, that they are both growing."

While PFM restorations topped the charts by a large margin, many of our readers are regularly placing metal-free options like porcelain veneers (70%), metal-free crowns (48%) and composite veneers (32%).

Computer assistance for labs

Culp, the founder of Mosaic Studios and the Institute for Oral Art and Design (*www.ioadsmiles.com*), admits that fellow technicians have given him a hard time for supporting Sirona and CAD/CAM technology, for fear that it would take business away from labs.

But the way he sees it, the day will indeed come when this technology changes the way labs and dentists practice, so they had better know how to use it.

"I take a lot of flack for helping Sirona because they have a clinical unit (CEREC 3) where dentists can make their own crowns, and I take a lot of flack from technicians for helping with this company," he said. "But what they don't understand is that it's going to happen, anyway. It's the evolution of things. CAD/CAM has just gotten to the point where people are comfortable with it and it's becoming mainstream now.

"The average dentist is familiar with zirconia and most of the brand names like Lava, Cercon, and CEREC inLab. Three years ago, they weren't."

Culp said large labs are investing in CAD/CAM technology and providing their services to smaller labs. "What you are seeing from the lab side is affecting the clinical side," he said. "CAD/CAM systems are allowing

DENTAL PRODUCTS REPORT SURVEY

PFMs still the way to go

Please indicate which of the following indirect restorations you place on a regular basis?*

PFM crowns	95%
PFM bridges	92%
All-gold crowns	70%
Porcelain veneers	70%
Metal-free crowns	48%
Composite veneers	32%
Ceramic inlays/onlays	31%
Metal-free bridges	19%
All-metal crowns	18%
(Lab-fabricated) CAD/CAM all-ceramic crowns	27%
Resin inlays/onlays	22%
(Lab-fabricated) CAD/CAM all-ceramic bridges	12%
CAD/CAM in-office all-ceramic crowns	8%
CAD/CAM in-office all-ceramic bridges	1%
Other	4%

*Multiple responses accepted.

Source: August 2005 DPR Indirect Esthetic Restorations Survey

Doctors' preferences

Do you ask your laboratory for a specific brand name of restorative system for each case?*

Yes	46%
No	55%

If yes, has your lab ever informed you that the restoration you requested would be inappropriate for your case or prep design?

Yes	60%
No	40%

*Total does not equal 100% due to rounding.

Source: August 2005 DPR Indirect Esthetic Restorations Survey

Temporaries

What types of material do you use for provisional restorations?*

Bis-acryl resin	73%
PMMA acrylic	32%
Microfill	15%
Thermoplastic	9%
PEMA	5%

*Multiple responses accepted.

anybody to do zirconia, because larger labs will buy two, three, four, or five units, and they go into the business of making copings. The small, two-man laboratory that can't afford a $60,000, $70,000, or $200,000 machine can send cases to one of these labs. So you don't have to spend a lot of money to get into the technology, because there are so many outsourcing labs making copings."

This outsourcing may explain the recent increase in usage for inLab and Lava systems. Advances in the technology have not hurt usage, either.

"Well, the software right now is so simple to use...half a day of training, and you can do 70% of anything you'd ever do," Culp said, adding that a bit of extra training could enable one to master the more advanced cases.

"But for the average technician making copings or dentists making crowns, the [amount of] training on this new software is very small. It's very intuitive and at the push of a button, it pretty well does everything for you," he pointed out.

Computer assistance in-office

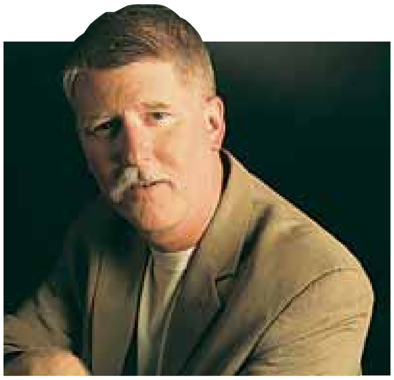
For doctors using CEREC chairside CAD/CAM restoration fabrication systems by Sirona (distributed by Patterson Dental Supply, *www.pattersondental.com)*, there is just no comparison between the first-generation of the technology and the current CEREC 3D system that was launched in 2003.

That might explain why the number of owners has grown from 5% in our September 2003 Equipment Survey[3] to 8% this summer in our latest technology survey.[1] Also, this current survey shows 8% of our readers regularly placing CAD/CAM in-office all-ceramic crowns.

Dr. Richard Masek, a CEREC pioneer who teaches CEREC continuing education courses at his training facility in the same building as his private dental practice in San Diego (Dentistry By Design, *www.mysmile.com*), said the technology has dramatically changed the way he practices dentistry. He also said the CEREC 3D is easier to use than CEREC's earlier versions.

A key benefit to in-office CAD/CAM restorations is eliminating the need for impressions, temporaries and multiple office visits. Patient issues with a temporary crown falling off during dinner or at an interview are no longer a concern, according to Dr. Masek. Also, if the restoration is completed in one visit, time and money can be saved and the patient will not be getting anesthetized at a second visit.

"Those are the kinds of things we can avoid with single-visit CAD/CAM



"CAD/CAM will become the norm." –Lee Culp, CDT

dentistry." Dr. Masek said.

Esthetic results have improved along with the CAD/CAM technology, which is why the likes of Culp and Dr. Masek expect the technology to one day be the norm in dentistry. "I was focused on creating restorations that would rival the accreditation standards of the AACD," said Dr. Masek, an accredited member of the American Academy of Cosmetic Dentistry. "I was doing my accreditation as I was learning my CEREC 1, but I knew I was not going to do anything within the realms of accreditation (with it). But as CEREC 2 came out and then CEREC 3 and CEREC 3D, it became really obvious that we are dealing with a technique and capabilities that are going to allow us to rival what could be done in a laboratory in single-visit dentistry," he said.

Dr. Masek first acquired his CEREC 2 about eight years ago. Once he realized the milling chamber allowed him to produce any kind of restoration, he then switched his focus to improving the esthetics of all CAD/CAM restorations. "How are

50%

increase in CAD/CAM

Over the past year, the percentage of GPs placing lab-fabricated CAD/CAM crowns has jumped to 27% from 18%, a 50% increase.

DENTAL PRODUCTS REPORT SURVEY

Not too many remakes, adjustments needed

The great majority of respondents (87% of labs[4] and 78% of doctors) said that less than 5% of all crown and bridge cases get sent back to the lab for remakes or adjustments. Additionally 12% of the labs and 10% of the doctors said none are sent back. But when they do get sent back, it's most often caused by problems with the contacts, the shade, or the fit.

Why completed cases are returned to the lab…

Doctors say:		**Labs say:**	
1. Shade	**80%**	1. Contacts	**70%**
2. Fit	**78%**	2. Shade	**61%**
3. Occlusion	**51%**	3. Fit	**46%**
4. Size/shape	**40%**	4. Occlusion	**40%**
5. Characterization	**29%**	5. Fracture/failure	**40%**

*Multiple responses accepted.

Source: February 2005 DLP and August 2005 DPR Indirect Esthetic Restorations surveys

Communication aids

The following are your top choices for aids employed by you and your laboratories to communicate case design and shade?*

Shade guides	**79%**
Telephone	**72%**
Study models	**72%**
Shade tabs	**57%**
Pre-printed prescription forms	**54%**
Photographs	**46%**
Direct technician contact with patient	**44%**
Stump shades	**39%**
E-mail digital images	**15%**
35mm prints or slides	**13%**

*Multiple responses accepted.

Source: August 2005 DPR Indirect Esthetic Restorations Survey

we going to raise the level of dentistry produced with this device to the mainstream or above?" he then asked himself. "That's really where my focus began to develop both in my patient care and in my teaching venues, with the courses that I began to write curriculum for, getting my training center together, and so on. To try and teach doctors not to take things at a mediocre level, but really push them off the deep end....to take them as high as they can possibly go," he said.

"CEREC 1 to CEREC 3D is like comparing a train to the space shuttle. I mean it's a big, big difference in terms of what can be done, not only in the ability of the operator to actually visualize what they are creating—because with CEREC 1, CEREC 2, and in the early CEREC 3 days, you had to have a three-dimensional imagination. You had to be able to look at two-dimensional representations and turn them into three-dimensional objects to really know what you were looking at. Whereas now, the 3D just makes it plain as day."

Dr. Masek also said that regular use of CEREC in-office can be a profit-maker due to the resulting savings in reduced lab costs, chairtime, and the elimination of impression materials and temporary restorations.

"One of the beauties of the system is that it doesn't take much to be at a complete break-even point, where the technology literally costs you nothing," he said. "There's a certain level—and it varies, depending on the practice—where if you simply replace X number of units that you were sending to the lab, and you no longer have the lab bill and the associated costs with producing that labwork, such as temporaries and impression materials and second visits. With most practices, it takes between 15 and 20 units a month and you're at a complete break-even point: where what you were spending in the lab as an ongoing permanent expense is now being channeled into a depreciable expense that you will ultimately own and still continue to use."

Dr. Masek said the technology has benefited his entire practice. "You have happy patients—*and* a happy staff, because they're involved in cutting-edge technology," he said. "If you let them be involved —maybe involved in some of the characterization phases of it, where they're putting a little bit of the artistry into the end result—it brings a level of satisfaction to the staff as well, because they're contributing at a higher level."

He added that the latest version is easy to learn and use. "I don't think there is a practitioner in the country today who could not make this a profitable portion of their practice. This is not something that is beyond anybody's ability to master," Dr. Masek asserted.

Culp concurs. "Anybody can make a crown—I mean anybody," he said. "CAD/CAM will take over restorative dentistry. We'll be moving into bigger systems that mill bigger things.

It'll be titanium and you'll be designing everything you do on a computer in the laboratory. And this will happen in the next couple years."

Teamwork

Technology also has improved doctor and lab communication, and has minimized the number of cases sent back to the lab for remakes or adjustments.

The good news is that 87% of labs and 78% of doctors said that less than 5% of all crown and bridge cases get sent back to the lab for remakes or adjustments.[4] On the infrequent occasions they do get returned, it's often caused by problems with contacts, shade, occlusion, or fit (see "Not too many remakes…" chart, at left).

According to the survey, the top method of communication for case design and shade was shade guides, at 79% (see "Communication aids" chart, page 16). Next came the good old telephone along with study models at 72%, followed by shade tabs (57%). With an increase in the use of digital cameras by both labs and doctors, it's no surprise that 46% use photographs and 15% use e-mailed digital images to communicate.

Culp expects streaming video to play a key role in communication down the road. "Everybody's getting used to digital photography, so that will continue to grow," he said. "Then we'll move into streaming video, where we're actually in the office with the dentist in communication while the patient's there real-time live and watching. And as far as direct technician contact with the patient goes, it depends on whether you are a local supplier or a national or international supplier. We have maybe two (local) clients, and the rest are all over the place. So we rely heavily on digital information."

Other survey highlights

In an effort to determine how many metal-free and PFM cases are prescribed each month, we asked you about your crown and bridge workload.

> "You have a very happy staff involved in cutting-edge technology."
>
> –Dr. Richard Masek

More than one-quarter of you told us that you prescribe no metal-free crowns; 38% prescribe between 1 and 5 each month. As far as PFM crowns go, 14% do from 1 to 5 a month, while 44% prescribe between 6 and 15 each month.

Only one-quarter prescribe any metal-free bridges, and of those, one-quarter do so for 1 to 5 patients a month. By far, the largest number of respondents (74%) prescribe 1-5 PFM bridges per month.

- The top choice for provisional materials is bis-acryl (73%), followed by PMMA acrylic (32%) and microfill 15%. (See "Temporaries" chart, page 15.)
- Less than half of the respondents ask their labs for a specific brand of restorative system for each case, which suggests doctors are pretty confident in their labs to provide what's best for most cases (see "Doctors' preferences" chart, page 15). Additionally, six in 10 of our readers report that the lab has come back to inform them that the requested restoration would be inappropriate for that particular case or prep design.

3M ESPE Marketing Manager Mark Konings said, "What we want people to do is prescribe Lava. Generally dentists do prescribe around brands, but it's a little bit different if it's a PFM. Captek, Procera, Lava, Empress, they have in mind what they want, even if they may or may not know much about the technology or how it got there. I doubt very many dentists would be writing on the prescription, 'CAD/CAM all-ceramic crowns.' " DPR

Stan Goff is the senior editor for Dental Products Report. He can be reached at 847-441-3739 or via e-mail at sgoff@advanstar.com.

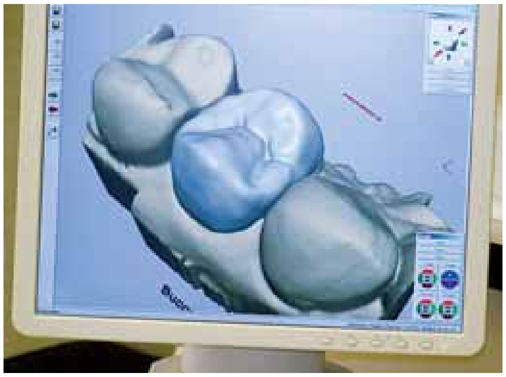
References

1. A DPR survey focusing on indirect restorations was sent to 2,000 GPS in August 2005. The results were tabulated from 347 returned surveys, a response rate of 17.4%.
2. A DPR survey focusing on indirect restorations was sent to 1,000 GPs in July 2004. The results were tabulated from 191 returned surveys, a response rate of 19.1%.
3. A DPR equipment survey was sent to 2,000 GPs in September 2003. The results were tabulated from 412 returned surveys, a response rate of 20.6%.
4. An indirect restorations survey was sent out by our sister publication, Dental Lab Products, in February 2005 to a random sampling of 1,000 owners/managers of dental laboratories. The results were tabulated from 267 returned surveys for a response rate of 27.1%

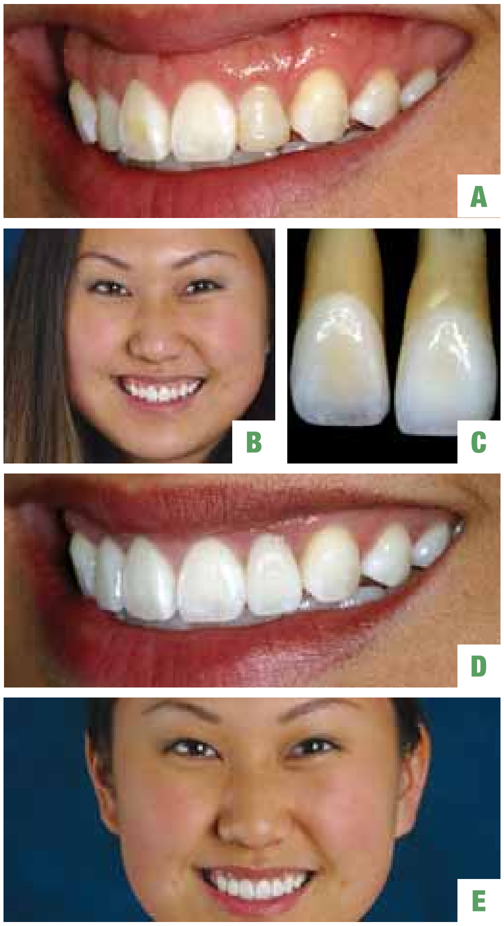
A CAD/CAM convert

With advances in software and milling materials, the newest generation of chairside CAD/CAM technology can produce restorations with lifelike esthetics and optimal fit.

By James Klim, DDS, FAGD, FADFE, PC



CEREC 3D software can adjust the database tooth and establish proper occlusal contacts.



This patient didn't like her gummy smile and prominent centrals **(A & B)**. CEREC veneers for the laterals were designed, milled, stained, and glazed **(C)**. The veneers, along with gingival recontouring and whitening, dramatically improved the smile **(D & E)**.

I'll admit, I was originally skeptical about the ability to produce a restoration that met my esthetic and fit standards with a chairside CAD/CAM system. The first time I looked at the CEREC system more than a decade ago, the refinement of the fit was not there and esthetic options were limited.

I've been using the CEREC 3D system now for about a year, and this latest generation has definitely addressed my concerns, for a number of reasons. Advances in both the system's software and the materials used for milling have allowed vast improvements in both fit and esthetics. Take a look at the photos within this article to see some examples of what I'm able to achieve. Keep in mind, I've only been using CEREC for just over one year.

Software

Perhaps I'm not the best barometer, because I am somewhat of a computer junkie. But I found the software very easy to master…much easier than something like PowerPoint. There are only a few primary tools you need to work with. And the system is set up to take you through each step in sequence—and, it won't let you override any steps. Additionally, each window has instructions at the bottom explaining what to do next. I was doing cases the day after my orientation.

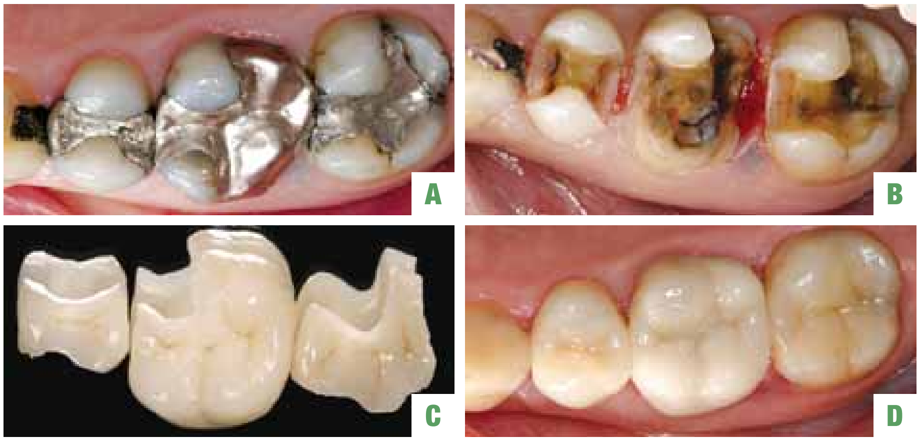
Not only is the software simple to learn and use, it's very sophisticated. Preps are captured at very high resolution, enhancing the precision—if you take a good optical impression, you're going to get a good virtual die. And I can design a three-dimensional prototype on the screen, so what you see is what you get.

Materials

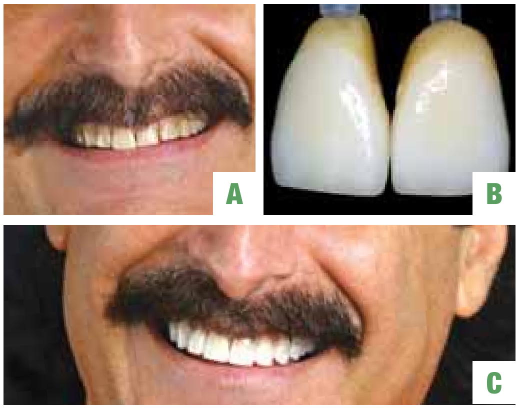
Another reason for my decision to use CEREC now is the availability of new milling materials. The newer-generation ceramic and resin blocks are strong and esthetic. I like leucite-crystal ProCAD blocks (Ivoclar Vivadent, *www.ivoclarvivadent. us.com*) as well as the Paradigm composite blocks (3M ESPE, *www.3MESPE.com*). Additionally, Vita trilayered blocks (Vident, *www.vident.com*) actually incorporate cervical, body, and incisal colors within the block; you can orient

James Klim, DDS

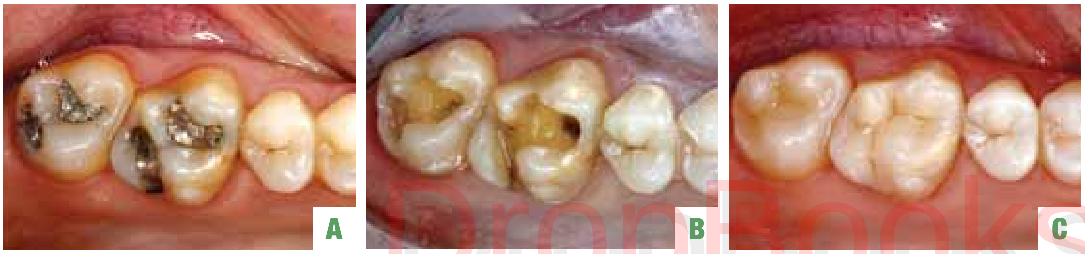
Dr. Klim maintains a private practice, The Gallery of Fine Smile Design, in Santa Rosa, Calif. He focuses on high-tech restorative and cranio-neuromuscular reconstructive esthetic dentistry. Dr. Klim is an accredited member of the American Academy of Cosmetic Dentistry and a fellow of both the Academy of General Dentistry and International Academy for Dental-Facial Esthetics; he was formerly a clinical instructor at LVI. He speaks around the country on practice management, high-tech dentistry, and esthetics. He's been using CEREC in his practice since October 2004.



This patient wanted these three worn amalgam restorations **(A)** replaced. They were removed and the teeth were prepped for conservation **(B)**. Stained and glazed CEREC inlays and onlays **(C)** provide seamless and natural esthetics **(D)**.



This patient's smile was uneven **(A)** and he wanted a fuller smile with teeth in more ideal proportions. We fabricated eight CEREC veneers **(B)** and vastly improved his smile **(C)**.



First molar exhibited cracked tooth symptoms **(A)**. Both amalgams were removed **(B)**. The CEREC inlays strengthened the teeth and provided optimal esthetics **(C)**.

on the screen exactly where you want these colors to be on the restoration. There's a great choice of materials that we didn't have just a few years ago.

All these new materials are easy to polish and wear similarly to enamel. Also, they offer the chameleon effect and blend in with surrounding dentition.

Manipulation

Perhaps the most dramatic advancement is the ability to enhance esthetics even after restorations are milled. There are three levels.

First, polishing—and the majority of CEREC users do this. Once you learn how, you can polish a beautiful restoration in four to five minutes. And with some of the layered blocks, this is all you have to do.

The next level up, if you are not ready to dive into full-blown staining and glazing, is to use composite stains. They're not particularly helpful on the labial surface in cervical areas. For thin areas, or with a transparent block, I can use stain within the tooth. While I typically only get a 10% to 15% shift in shade, the chameleon effect kicks in again, and the restorations melt in the mouth.

I take 80% of my cases to the third level…staining and glazing. This adds some time to the processing, but the esthetic improvement is dramatic. It's particularly helpful for challenging cases, especially when I'm trying to blend a single restoration in with surrounding dentition. I can control features like incisal transparency better than a lab because the patient is right there.

Staining and glazing has an added value—it makes the restoration that much stronger by sealing potential microfractures that might result from the milling process. Additionally, studies have shown that staining and glazing significantly increases shear resistance. Finally, because I do a lot of single-appointment quadrant cases, staining and glazing is truly time efficient, I can work on the first three units while the molar is being milled.

Beyond computers

Perhaps even more than being computer savvy, I think the key to success with CEREC, as it is with lab-fabricated metal-free restorations, is a basic understanding of adhesive dentistry. I have heard from CEREC trainers that some of the new CEREC users they are working with don't have a lot of experience with the particular intricacies of metal-free dentistry—preparation design, occlusion, soft-tissue management. These issues are common to all non-metal indirect restorations, and once the practitioner knows all the requirements, the learning curve for mastering CEREC will be a breeze. DPR

Occlusion software upgrade

Features

- Automates the process of establishing occlusal clinical relationship to the antagonist
- A click of the mouse adjusts the database tooth and establishes occlusal contacts
- Proposed crown needs minimal fine-tuning prior to milling
- Minimizes adjustment on final crown

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800-659-5977

The right bite

Automated occlusion establishes contact with a mouse click

Information provided by Sirona Dental Systems LLC.

Dubbed the "self-adjusting crown," the automatic occlusion tool of the latest version of **CEREC 3D** software has eliminated the need for any manual alignment by the clinician. With a few clicks of the mouse, the software adjusts the database tooth and automatically pre-determines the occlusal contacts. The occlusal relationship to the antagonist is established automatically. This not only improves fit and function, but saves time by minimizing the need for adjustment before milling (digitally) and after milling (manually).

CEREC's set of dental databases lets the user select from a wide array of abrasion options to correspond to the patient's dentition. This allows the software to virtually replicate natural teeth.

Additional customization is possible by using any existing occlusion as a database. For example, for a crown on tooth No. 3, the closest match might be a mirror image of the patient's tooth No. 14. The digital impression of tooth No. 14 can be mirrored and pasted into the design of tooth No. 3.

Here's a brief pictorial overview of the one-visit, in-office procedure.

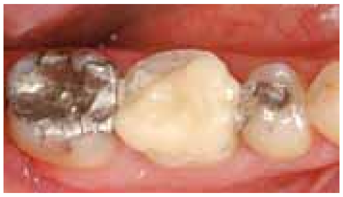

Fig. 1 Pre-operative condition: Composite on tooth No. 19 needs replacement.

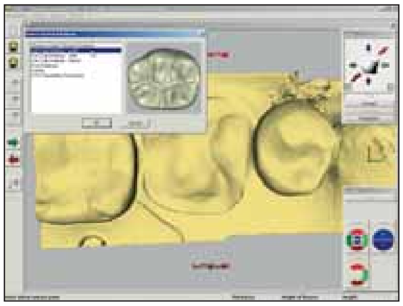

Fig. 3 The appropriate design is chosen from the comprehensive database to match the scanned prep.

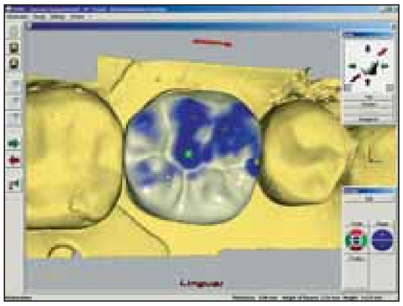

Fig. 4 The first contacts are created on the proposed crown.

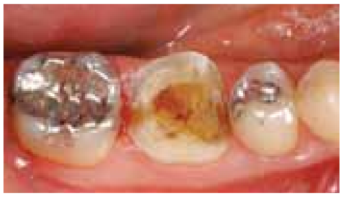

Fig. 2 Composite is removed and tooth is prepped.

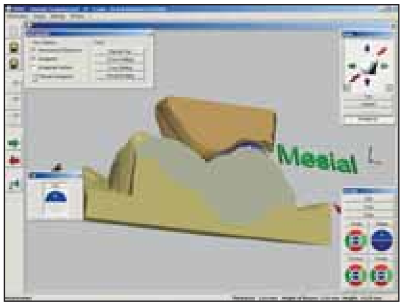

Fig. 5 The "Antagonist" tool determines the need for designing additional contacts.

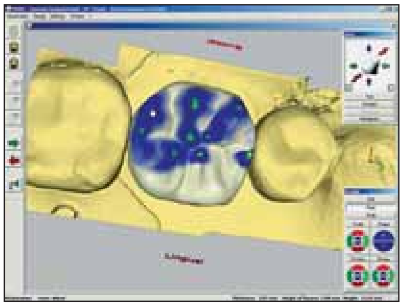

Fig. 6 The software's "Drop" tool performs final smoothing of contacts.

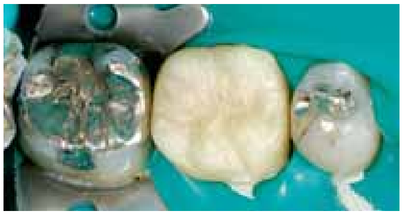

Fig. 7 The milled crown is fitted.

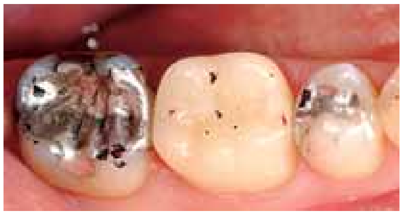

Fig. 8 The static and dynamic contacts of the adjusted crown are checked.

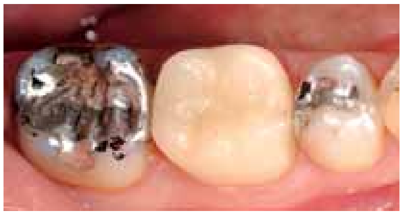

Fig. 9 The final restoration exhibits proper occlusion and a high-gloss finish after polishing.

Impressions… virtually

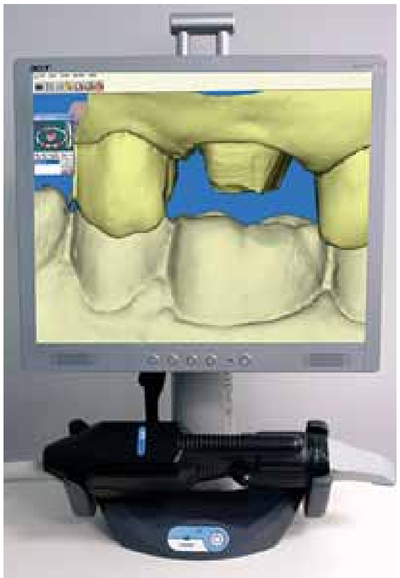

Photo courtesy of Cadent Inc.

The intraoral digital impression taken by the Cadent scanner is transmitted to the lab for coping design.

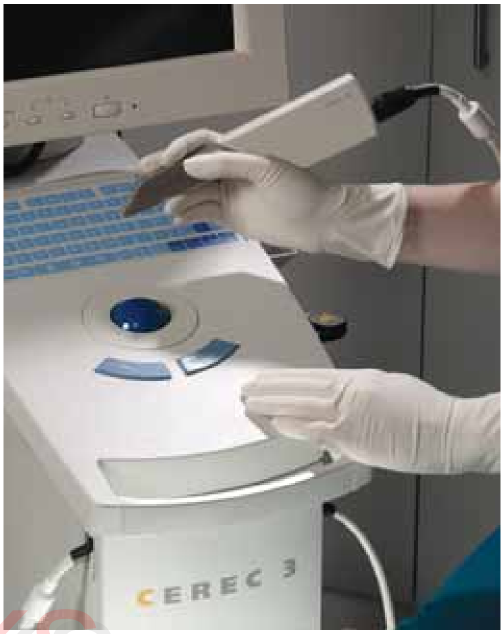

Photo courtesy of Sirona Dental Systems.

The CEREC 3 "camera" is positioned over the prep. With the push of a button, an instant optical impression is captured.

Digital technology is making inroads into yet another arena…impression taking. The days of mixing, syringing, and gagging may someday just be distant memories, replaced by no-mess digital scanning.

What if every impression you took was guaranteed to have clearly defined margins, never distorted, and always included opposing dentition and jaw relation? No way? Well, maybe not.

Enter digital impressioning. Using optical scanning technology, it digitally captures all the same information provided in conventional impressions, bite registrations, etc., but without all the variables and outside influences that affect accuracy. The scanning technology exists in various forms already in laboratory systems. But the only *intraoral* digital impression system currently in use is part of Sirona's CEREC chairside CAD/CAM restoration system. It has evolved and now provides true three-dimensional impressions that simplify restoration design.

Scheduled to be unveiled at the 2006 Chicago Dental Society Midwinter Meeting, the EID (Electronic Impression Device) intraoral scanner from New Jersey-based Cadent will be offered for chairside capturing of intraoral digital impressions, which will be used by the lab to design copings and fabricate restorations. This differs from the current lab CAD/CAM systems in that all conventional impressions are eliminated from clinical procedures.

Both the CEREC and Cadent intraoral scanners capture the three-dimensional geometry of preparations and any other relevant structures (e.g., opposing occlusion, adjacent teeth, etc.). Magnified digital "models" are displayed chairside and the clinician can make adjustments. For CEREC, the data is transmitted to the in-office milling machine for restoration fabrication. With the Cadent, the data is transmitted to the lab for coping design and subsequent processing.

Some of the implications of this emerging technology for the dental team were articulated recently by Bennet Napier, co-executive director of the National Association of Dental Laboratories in a letter to the American Dental Association Workforce Task Force:

"The future of in-operatory CAD/CAM systems will create a need for a dental technician team member who will have enhanced computer skills, design skills, material knowledge and skills in patient care. With the continued integration of CAD/CAM technology both currently in use within the dental operatory and dental laboratory, the need for dental team personnel to have adequate skills in computer processing and equipment usage will be of importance."

Given the clinical and productivity benefits of digital impression taking, these issues appear to be worth addressing. Even impression material manufacturers acknowledge, as have dental x-ray film manufacturers, that the digital age is definitely coming. DPR

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CEREC's been around the block. Not too many products in dentistry can honestly lay claim to the status of "icon." CEREC can. After 20 years and millions of successful restorations worldwide, the revolutionary CEREC way of working has impressed patients and clinicians alike.

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